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A Summary of the Interlaboratory Source Performance Surveys for EPA Reference Methods 6 and 7 — 1977

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This report summarizes the 1977 results of a source methods survey program conducted by the Quality Assurance Branch of the Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency. As part of these surveys, test solutions prepared as internal quality control samples were sent to interested participants in May and November for analysis by EPA Source Method 6 for SO_2 and EPA Source Method 7 for NO_x. Each participant returned the analytical results to the Quality Assurance Branch for evaluation; an individual report was returned to each participant after processing.

This report contains a summary of the survey results for the analytical portion of these two source methods.

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FOREWORD

Measurement and monitoring research efforts are designed to anticipate potential environmental problems, to support regulatory actions by developing an in-depth understanding of the nature and processes that impact health and the ecology, to provide innovative means of monitoring compliance with regulations and to evaluate the effectiveness of health and environmental protection efforts through the monitoring of long-term trends. The Environmental Monitoring and Support Laboratory, Research Triangle Park, North Carolina, is responsible for development of: environmental monitoring technology and systems; agency-wide quality assurance programs for air pollution measurement systems; and technical support to the Agency's operating functions including the Office of Air, Noise and Radiation, the Office of Toxic Substances and the Office of Enforcement.

The primary concern of this study was to initiate a nationwide quality assurance program with which to estimate the analytical and computational accuracy that could be expected from users of EPA source reference method 6 for sulfur dioxide and method 7 for nitrogen oxides. Statistical analysis was used to characterize the data.

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Director
Environmental Monitoring and
Support Laboratory

ABSTRACT

This report summarizes the 1977 results of a stationary source test method survey program conducted by the Quality Assurance Branch of the Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency. In this program, quality assurance samples were sent to interested participants for analysis by EPA Reference Method 6 for sulfur dioxide (SO_2) and EPA Reference Method 7 for nitrogen oxides (NO_x). Each participant returned the analytical results to the Quality Assurance Branch for evaluation; an individual report was returned to each participant after processing.

This report contains a summary of the survey results for the analytical portion of these two source test methods.

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SECTION 1

INTRODUCTION

The periodic analysis of a quality control reference sample originating outside the laboratory in which it is used, should be an integral part of any laboratory quality assurance program. Therefore, in 1972 the Environmental Protection Agency (EPA) organized a nationwide performance audit program to provide consistent audit materials for use with ambient air reference methods. Since that time, a number of performance audits of laboratories measuring ambient air pollutants have been conducted (1,2). In 1976, EPA expanded this program to provide quality assurance materials that could be used to perform similar performance surveys of stationary source test methods. This latter program had three main purposes:

- to verify that the analytical parts of the specific reference methods were being used properly;
- to uncover any laboratory bias in the analytical portion of the test method; and
- to improve the quality of the measurements being made.

These goals were realized by sending specific performance materials to interested laboratories for analysis.

In our first two surveys, we chose to examine the analytical part of Method 6 for sulfur dioxide (SO_2) and Method 7 for nitrogen oxides (NO_x) (3,4). This report describes the preparation and evaluation of these surveys held in May and November of 1977.

SECTION 2

SUMMARY

The quality assurance surveys conducted in 1977 by the Quality Assurance Branch (QAB) of EPA's Environmental Monitoring and Support Laboratory included participants from industry, contracting firms, universities, foreign countries, and governmental agencies.

An average of 120 participants requested samples for the first two surveys of Method 6 (SO_2), with an average data submission rate of about 69%. The number of participants requesting samples for the two surveys of Method 7 (NO_x) averaged 113, with an average response rate of 58%. This response was judged acceptable with respect to earlier EPA ambient air audits.

The first survey for Method 6 (SO_2) (survey 0577 conducted in May 1977) reveals that 50% of the participants measured their samples at a 2.15% or less absolute difference from their true values; in the second survey (survey 1177 conducted in November 1977), this difference was lower at 1.69%.

For Method 7 (NO_x), the absolute difference was 15.14% or less for 50% of the participants in survey 0577, while in survey 1177, the absolute difference was 7.41% or less. These statistics indicate the pronounced difficulty of Method 7 for the analyst, relative to Method 6.

Examination of the data generated by the five test samples sent to each participant for each method indicated that for Method 6 (SO_2) 17% of the participants in survey 0577 had 2 or less samples correctly measured within the target range while in survey 1177, 14% were within this range. Method 7 results show that in survey 0577, 42% of the participants had 2 or less samples correctly measured within the target range while survey 1177 had 25% within this range. Presently, the sample and target ranges are based on the results of a collaborative test (5) of Methods 6 and 7, and a titration specification for Method 6 that is listed in the Federal Register. These ranges are more adequately defined in Section 5 (Statistical Data Handling).

Follow-up surveys will examine trends in the analytical abilities of users of these source methods by evaluating a participant's results based on previous results in that same concentration range.

SECTION 3

RECOMMENDATIONS

To create a sample repository the Quality Assurance Branch of the Environmental Monitoring and Support Laboratory intentionally produced an oversupply of samples for the surveys of EPA Methods 6 and 7 discussed in this report. These samples are available to any laboratory having a legitimate need for them, such as training new analysts, and conducting periodic external quality control checks of the laboratory. Included with these practice samples is a statement of true concentration with no requirement for return of data to EPA. We would like to recommend to any participant use of this sample repository especially if their reported values fell outside the target range in more than two out of five samples. We hope that through use of this sample repository, laboratories will increase their overall analytical skills concerning these particular EPA reference methods.

SECTION 4

SURVEY DESIGN

The source sample surveys of this report incorporate experience gained from previous ambient air audits in such areas as survey procedures, prospective participants, types and preparation of survey materials, and data handling. Most procedures described in this section closely follow the manner in which ambient air audits have been performed.

SURVEY PROCEDURES

All surveys began with a master list of prospective laboratories who had in the past participated or indicated that they wished to take part in such a program.

Prospective participants were sent a description of the Method 6 and 7 surveys and instructions for participation. Through a response card, each laboratory indicated if it wished to participate. Response cards were returned to the appropriate EPA Regional Quality Control Coordinator (RQCC) who collected, logged, and forwarded them to the EPA contractor preparing the survey materials under contract to the Quality Assurance Branch. Participating laboratories were assigned an identification number to facilitate storage of their data in the computer's data bank, and to maintain confidentiality for each participant. At a prearranged date, requested survey materials were shipped to the participants along with instructions for sample analysis; a blank data card to report the completed analysis values; and a mailing label for return of the data card to the QAB. When the survey was completed each participant received a computer data sheet informing them of their performance. At the completion of several studies, a summary of all the participants' results will be published without reference to any specific laboratory.

PROSPECTIVE PARTICIPANTS

Many governmental agencies were contacted to generate a master list of prospective participants including federal, state, and local agencies. To contact industrial, university, or consultant firms, several publications specializing in source sampling and analysis were examined. Announcements of the source surveys were placed in such periodicals as the EPA Quality Assurance Newsletter, Stacksampling News, and the Journal of the Air Pollution Control Association. Invitations were extended to all prospective participants. Other laboratories were added to the master list through their direct contact with the QAB or the RQCC.

PREPARATION AND DISTRIBUTION OF SURVEY MATERIALS FOR METHOD 6 AND 7

Four different concentration levels of simulated source SO_2 and NO_x samples were prepared for survey 0577, and five for survey 1177. These solutions enabled the participants to analyze and calculate different concentration levels of SO_2 and NO_x using Methods 6 and 7. The "true values" of these samples were based on theoretical concentrations calculated from gravimetric preparations, and certain assumed volume measurements. After sample solutions were made, their concentrations were verified with the appropriate methods. This was initially conducted by contractor personnel and then by EPA personnel, via a process known as Acceptance Testing.

In survey 0577, samples were distributed in 15 ml glass vials sealed with inert lined screw-cap closures. Each laboratory received one vial each of the four concentration levels and a duplicate of one level. The samples were packaged in a styrofoam mailer and a cardboard box lined with absorbant material in case of breakage during shipment. In survey 1177, each sample solution was sealed in a 25 ml glass ampoule, and five different concentration levels were shipped to the participating laboratories. Glass ampoules were preferred over vials to prevent leakage and to insure longevity of the concentrations. The ampoules containing NO_x samples were autoclaved to destroy bacteria that might possibly attack the solutions.

In the first survey each vial contained in excess of 10 ml of solution; in the second survey ampoules contained approximately 20 ml.

Instructions for the Method 6 samples prescribe that 5 ml of the test solution be diluted to 100 ml through the addition of 30 ml of 3% hydrogen peroxide (H_2O_2) and distilled water. An aliquot of this solution was then titrated with barium perchlorate ($Ba[ClO_4]_2$) in the presence of thorin indicator to a characteristic peach color endpoint. To complete Method 6 calculations, the participants assumed they had an original sample volume of 100-ml, and had sampled 21×10^{-3} DSCM (dry standard cubic meter) of stack gas.

The analysis of Method 7 samples involved a 5 ml dilution of the original test sample with 25 ml of absorbing reagent; adjustment of the pH to approximately 9 to 12; and dilution to 50 ml with distilled water. After a digestion procedure, colorimetric analysis follows. To complete Method 7 calculations, the participants were to assume they had sampled 2000 ml of stack gas.

In each of our surveys, the samples were number coded. In the first survey (0577), each sample was given a unique five digit number, where the middle digit indicated one of the four concentration levels used in preparing the sample sets. For the second survey (1177), the key for the five concentration levels was based on the first digit of the sample number.

SECTION 5

STATISTICAL DATA HANDLING

Establishing criteria in order to evaluate reported data was a major concern of the survey program. The most ideal approach would have been to evaluate a large number of analyses of the same sample made by laboratories across the nation at different times. Since this was impossible, as an alternative, performance ranges were established based on the collaborative studies of Method 6 and 7 conducted by Southwest Research Institute (SwRI) (5) under contract to EPA. The SwRI collaborative study estimated the within-laboratory standard deviation ($\hat{\sigma}$) for the analytical phase of Method 6 to be 1.1% of the true concentration (δ) over a simulated range of 283 to 848 mg SO_2/DSCM. Therefore, $\hat{\sigma} = 0.011\delta$ was used for the Method 6 survey. The following are two performance ranges employed to describe participants' results. The sample range for each concentration level was determined as $\pm (1.96)(0.011\delta)$ or approximately $\pm$ 2.2% of δ; the target range was set at twice that or $\pm$ 4.4% of δ. The t-statistic, 1.96, was used to estimate where 95 percent of the analysis was expected to fall assuming normally distributed sample results. Section 4.3 of Method 6 specifies that replicate titrations must agree within 1% or 0.2 ml, whichever is larger. Since this titration specification affects all sample ranges below a concentration of 686 mg/DSCM, it was used rather than the collaborative study results to establish the sample and target ranges for concentrations below this level.

The two performance ranges for the Method 7 survey were calculated from a regression equation developed from the aforementioned SwRI collaborative test data. Using collaborative test data, equation 1 describes the within-laboratory standard deviation ($\hat{\sigma}_N$) for Method 7 (NO_x) over a simulated concentration range of 125 to 375 mg NO_2/m^3, assuming a sample volume of 2000 ml.

$$\hat{\sigma}_N = 0.031428\delta + 0.5802 \text{ mg/m}^3 \qquad (1)$$

Thus, the sample range was defined as $\pm 1.96\hat{\sigma}_N$ with a target range twice that value or $\pm$ 2 ($1.96\hat{\sigma}_N$). The target range was established to separate marginally adequate results from the more questionable ones.

It is important to note that sample and target ranges are bench marks, and judgment must be used by the participants in interpreting their results. Furthermore, the combined performance of all five analyses has a bearing on the adequacy of a participant's skills.

In summarizing the collected data, an outlier test (6) deletes data lying outside the mean of the reported values by a factor of from 2 to 3.3 standard deviations, depending on the number of samples for a particular test.

SECTION 6

DISCUSSION OF METHOD 6 RESULTS

The participants' organization and the distribution of source sulfur dioxide survey numbers 0577 and 1177 are shown in Table 1 and 2 below.

TABLE 1. METHOD 6 SURVEY 0577

	Laboratory Distribution							
	Contractor	Industrial	Federal	State	Local	University	Foreign	Total
Agencies requesting samples	77	14	2	12	8	1	2	116
Agencies returning data	46	12	2	11	8	1	2	82

TABLE 2. METHOD 6 SURVEY 1177

	Laboratory Distribution							
	Contractor	Industrial	Federal	State	Local	University	Foreign	Total
Agencies requesting samples	71	20	3	16	12	0	2	124
Agencies returning data	50	12	1	11	8	0	2	84

Participants were instructed to use Method 6 for all analyses and report their results, based on equation 6-2 of the method (mg SO_2/DSCM), on a blank data card.

In both Method 6 surveys (0577 and 1177), only the sample and target ranges (Tables 3 and 4) of low SO_2 concentrations (266.91 and 137.30 mg/DSCM) were affected by Method 6 titration specifications and reflect this by their larger values. The participants should realize that the titration specification was not reflected in the initial reports received; therefore, samples 1 and 9 in survey 0577, and sample 5 in survey 1177 should be examined to see if their values do fall within the new sample and target ranges. These new ranges are reflected in all Method 6 statistics within this report.

TABLE 3. METHOD 6 ACCEPTANCE RANGES (SURVEY 0577)

Sample number	Concentration* level	Sample range		Target range	
		Percent	Concentration*	Percent	Concentration*
1 & 9	266.91	± 5.7	251.6 - 282.1	± 5.7	251.6 - 282.1
2 & 7	5338.19	± 2.2	5220.7 - 5455.6	± 4.4	5103.3 - 5573.0
3 & 6	3812.99	± 2.2	3729.1 - 3896.8	± 4.4	3645.2 - 3980.7
4 & 8	2097.15	± 2.2	2051.0 - 2143.3	± 4.4	2004.8 - 2189.4

*All sample concentrations are in mg SO_2/DSCM.

TABLE 4. METHOD 6 ACCEPTANCE RANGES (SURVEY 1177)

Sample number	Concentration* level	Sample range		Target range	
		Percent	Concentration*	Percent	Concentration*
2	4346.90	± 2.2	4251.2 - 4442.5	± 4.4	4155.6 - 4538.1
4	5147.60	± 2.2	5034.3 - 5260.8	± 4.4	4921.1 - 5374.0
5	137.30	±11.1	122.0 - 152.5	±11.1	122.0 - 152.5
7	1410.90	± 2.2	1379.8 - 1441.9	± 4.4	1348.8 - 1472.9
8	2592.90	± 2.2	2535.8 - 2649.9	± 4.4	2478.8 - 2706.9

*All sample concentrations are in mg SO_2/DSCM.

Also noteworthy is that for sample concentrations below 305 mg/DSCM the sample and target range percentages are the same since the percent difference from the true value allowed by the titration specification is larger than that determined from collaborative testing data; and doubling a sample range based on this specification, as in target ranges, would mean one could exceed the

titration specification and still be within the target range. Using the previously defined sample and target ranges, a tabulation of all data (Table 5) indicates that 15% of the laboratories in survey 0577 recorded "none" correctly measured within the sample range; however, in survey 1177, only 6% measured "none" correctly.

TABLE 5. METHOD 6 SAMPLE RANGE CUMULATIVE DISTRIBUTION

No. of correctly measured samples	% Participants correct	
	Survey 0577	Survey 1177
1	85	94
2	68	74
3	58	68
4	41	56
5	24	46

Of the participants in survey 0577 (Table 6), 11% measured no sample correctly within the target range, and 6% in survey 1177 measured none correctly.

TABLE 6. METHOD 6 TARGET RANGE CUMULATIVE DISTRIBUTION

No. of correctly measured samples	% Participants correct	
	Survey 0577	Survey 1177
1	89	94
2	83	86
3	77	84
4	65	82
5	43	70

We found that in survey 1177, 68% (Table 5) of the participants measured three or more samples correctly within the sample range, and 84% (Table 6) measured three or more correctly within the target range. These tables can inform a participant of his relative performance in comparison to all participants.

Tables 7 and 8 are frequency distributions of the absolute percent differences between the participant's reported values and EPA values for each concentration level. The differences were calculated as follows:

$$\text{Absolute percent difference} = \left| \frac{\text{Reported value - EPA value}}{\text{EPA value}} \right| \times 100 \qquad (2)$$

Table 7 reveals that 50% of the reported results for all sample concentration levels of Method 6 survey 0577 were less than or equal to an absolute percent difference of 2.15. The bottom line of this table compiles all the data regardless of concentration. Table 7 is also useful for self-evaluation. For instance, a participant reporting a value for sample 4 having a significantly greater than 3.52% difference would recognize the discrepancy, since more than 70% of the participants performed more accurately. The minimum (Min) and maximum (Max) values listed in Tables 7 and 8 show the lowest and highest individual percent differences reported in the survey.

All results are grouped according to increasing reported concentration levels in Appendix A to allow individuals to note their exact placement in the survey results.

Tables 9 and 11 list summary statistics based on all data received. In contrast, Tables 10 and 12 list summary statistics based on data remaining after statistical tests for outliers had been performed. Equations 3, 4, and 5 were used to calculate the statistics in these tables:

$$\% \text{ Coefficient of variation} = \frac{\sigma}{\bar{X}} \times 100; \qquad (3)$$

$$\text{Skewness} = \frac{\Sigma(X_i - \bar{X})^3}{n(\sigma)^3}; \qquad (4)$$

$$\text{Accuracy} = \frac{Mi - \delta}{\delta} \times 100 . \qquad (5)$$

where: σ = one standard deviation

$\bar{X}$ = mean value

X_i = individual value

Mi = median value

δ = true value

n = number of values

TABLE 7. METHOD 6 SURVEY 0577 - FREQUENCY DISTRIBUTION OF ABSOLUTE PERCENT DIFFERENCE

	No.	Min	10%	20%	30%	40%	50%	60%	70%	80%	90%	Max	Mean
# Within sample range	82	0	0	1	1	2	3	4	4	5	5	5	
# Within target range	82	0	0	2	3	4	4	5	5	5	5	5	
Sample 1	50	0.00	0.22	0.75	1.49	1.99	3.03	5.10	6.85	11.21	18.05	122.66	11.23
Sample 2	53	0.04	0.15	0.89	1.16	1.43	2.05	2.68	4.06	5.95	14.58	130.79	14.04
Sample 3	51	0.03	0.18	0.55	0.82	1.13	1.36	2.35	3.49	5.06	13.51	131.99	11.58
Sample 4	53	0.04	0.23	0.47	0.67	1.11	1.65	2.45	3.52	4.25	11.64	152.86	13.10
Sample 6	45	0.24	0.45	0.64	0.93	1.17	1.86	2.28	3.36	4.50	6.20	98.01	7.90
Sample 7	48	0.01	0.20	0.42	0.96	1.44	1.84	2.55	3.71	5.21	80.51	131.65	14.72
Sample 8	48	0.01	0.09	0.41	0.55	0.82	1.43	2.47	3.13	3.84	12.17	98.99	10.36
Sample 9	49	0.11	0.56	0.94	1.61	2.59	2.96	3.08	6.00	9.40	25.63	1313.81	37.78
All samples	397	0.00	0.32	0.63	1.00	1.43	2.15	3.00	3.83	6.32	28.66	1313.81	15.12

TABLE 8. METHOD 6 SURVEY 1177 - FREQUENCY DISTRIBUTION OF ABSOLUTE PERCENT DIFFERENCE

	No.	Min	10%	20%	30%	40%	50%	60%	70%	80%	90%	Max	Mean
# Within sample range	84	0	1	1	2	3	4	5	5	5	5	5	
# Within target range	84	0	1	4	4	5	5	5	5	5	5	5	
Sample 2	84	0.03	0.32	0.51	0.78	1.07	1.31	1.64	2.05	2.70	5.04	19.16	2.43
Sample 4	83	0.01	0.26	0.56	0.87	1.06	1.43	1.78	2.52	3.06	5.33	19.41	2.63
Sample 5	83	0.00	0.73	1.09	1.97	2.33	2.77	3.86	6.70	12.45	26.66	318.06	13.73
Sample 7	85*	0.04	0.40	0.79	1.06	1.34	1.68	2.19	2.62	3.11	6.57	32.89	3.13
Sample 8	84	0.00	0.34	0.61	0.88	1.16	1.35	1.72	2.25	2.90	3.95	19.53	2.27
All samples	419	0.00	0.40	0.75	1.04	1.31	1.69	2.22	2.69	4.00	8.02	318.06	4.82

*One participant received two number 7 samples and lacked a number 5.

TABLE 9. METHOD 6 SURVEY 0577 - SUMMARY STATISTICS

Sample #	1	9	4	8	3	6	2	7
# of samples	50	49	54	48	51	45	53	48
True value*	266.91	266.91	2097.15	2097.15	3812.99	3812.99	5338.19	5338.19
Mean*	266.08	321.71	2070.41	1903.28	3661.93	3614.52	4927.29	4917.33
Median*	268.05	267.80	2085.20	2085.85	3783.00	3774.90	5274.30	5299.45
Std. dev.*	73.57	508.01	770.93	551.13	1152.60	824.18	1830.05	1879.45
% Coef. var.	27.65	157.91	37.24	28.96	31.48	22.80	37.14	38.22
Skewness	-0.04	6.39	1.22	-2.78	0.28	-3.28	-0.37	-0.16
Accuracy	0.43	0.33	-0.57	-0.54	-0.79	-1.00	-1.20	-0.73

*All sample concentrations are in mg/DSCM.

TABLE 10. METHOD 6 SURVEY 0577 - SUMMARY STATISTICS (OUTLIERS REMOVED)

Sample #	1	9	4	8	3	6	2	7
# of samples	47	48	51	44	48	43	52	44
True value*	266.91	266.91	2097.15	2097.15	3812.99	3812.99	5338.19	5338.19
Mean*	270.29	249.79	1952.62	2063.80	3704.68	3778.20	4785.12	5075.96
Median*	268.50	267.50	2083.00	2087.55	3783.50	3776.20	5274.25	5316.60
Std. dev.*	19.88	68.97	490.86	114.35	531.70	307.20	1523.99	964.97
% Coef. var.	7.36	27.61	25.14	5.54	14.35	8.14	31.85	19.01
Skewness	0.07	-2.72	-3.51	-3.36	-3.38	1.91	-2.58	-3.79
Accuracy	0.60	0.22	-0.67	-0.46	-0.77	-0.96	-1.20	-0.40

*All sample concentrations are in mg/DSCM .

TABLE 11. METHOD 6 SURVEY 1177 - SUMMARY STATISTICS

Sample #	5	7	8	2	4
# of samples	83	85	84	84	83
True value*	137.30	1410.90	2592.90	4346.90	5147.60
Mean*	147.19	1393.95	2567.51	4304.32	5071.62
Median*	138.70	1391.70	2562.60	4298.70	5085.70
Std. dev.*	54.83	78.39	94.92	177.74	220.28
% Coef. var.	37.25	5.62	3.70	4.13	4.34
Skewness	5.73	2.63	0.24	0.86	-0.09
Accuracy	1.02	-1.36	-1.17	-1.11	-1.20

*All sample concentrations are in mg/DSCM.

TABLE 12. METHOD 6 SURVEY 1177 - SUMMARY STATISTICS (OUTLIERS REMOVED)

Sample #	5	7	8	2	4
# of samples	82	82	81	80	79
True value*	137.30	1410.90	2592.90	4346.90	5147.60
Mean*	141.98	1388.02	2563.91	4289.43	5073.45
Median*	138.65	1391.45	2562.40	4295.70	5085.70
Std. dev.*	27.70	43.21	50.68	88.74	110.78
% Coef. var.	19.51	3.11	1.98	2.07	2.18
Skewness	0.97	-0.28	0.22	-0.67	0.28
Accuracy	0.98	-1.38	-1.18	-1.18	-1.20

*All sample concentrations are in mg/DSCM.

As previously stated, participants in survey 0577 received a set of five samples from the four prepared concentration levels. These contained one sample from each concentration level and one duplicate. Samples 6 through 9 were prepared as duplicates of samples 1 through 4. No sample 5 was prepared. For instance, a participant could receive samples 1, 2, 3, 4, and 8. In this particular set of samples, the duplicate sample concentrations were numbers 4 and 8. When randomizing the distribution of duplicates for the four SO_2 concentration levels sent out, all sets of samples that included more than one set of duplicate concentrations were rejected; thus, each sample could act as a duplicate an approximate equal number of times.

In survey 1177 participants received one sample from each of the five prepared concentration levels. In both surveys the sample numbers were chosen at random from 0 through 9.

From an examination of Tables 10 and 12, it seems apparent that a negative bias exists in survey 0577 as judged by its skewness values (Table 10), particularly when outliers are removed. However, the differences between true and mean values were not statistically large enough to confirm a bias. This is also implied by the low accuracy values. Survey 1177 (Table 12) shows no indication of bias. Therefore, the "true value" adopted by EPA to represent the absolute true value and the mean agree well, indicating that the gravimetric preparation, reference method, and procedure for the survey coincide.

All samples listed in Tables 9 and 10 are in increasing concentration levels inclusive of duplicate samples.

SECTION 7

DISCUSSION OF METHOD 7 RESULTS

The source nitrogen oxides Survey 0577 and 1177 began, as with the Method 6 surveys, in May and November of 1977, respectively. The following tables describe the organization and distribution of those samples.

TABLE 13. METHOD 7 SURVEY 0577

	Laboratory Distribution							
	Contractor	Industrial	Federal	State	Local	University	Foreign	Total
Agencies requesting samples	72	8	2	9	8	1	2	102
Agencies returning data	39	8	2	6	6	1	2	64

TABLE 14. METHOD 7 SURVEY 1177

	Laboratory Distribution							
	Contractor	Industrial	Federal	State	Local	University	Foreign	Total
Agencies requesting samples	70	20	3	16	12	0	3	124
Agencies returning data	43	9	1	6	7	0	2	68

Participants were instructed to use Reference Method 7 for their analysis and report their results based on equation 7-4 of the method as mg NO_x/DSCM. Under Part 6 (Calculations) of Method 7, the analyst is required to calculate the concentration of NO_x samples as NO_2.

Sample and target ranges (Tables 15 and 16) were defined using the regression equation described in Section 5.

TABLE 15. METHOD 7 ACCEPTANCE RANGES (SURVEY 0577)

Sample number	Concentration* level	$\hat{\sigma}_N$	Sample range concentration*	Target range concentration*
1 and 6	1913.80	60.73	1794.8 - 2032.8	1675.8 - 2151.9
2 and 9	95.70	3.59	88.7 - 102.7	81.6 - 109.8
3 and 7	669.80	21.63	627.4 - 712.2	585.0 - 754.6
4 and 8	1435.40	45.69	1345.9 - 1525.0	1256.3 - 1614.5

*All sample concentrations are in mg NO_x/DSCM.

TABLE 16. METHOD 7 ACCEPTANCE RANGES (SURVEY 1177)

Sample number	Concentration* level	$\hat{\sigma}_N$	Sample range concentration*	Target range concentration*
1	421.00	13.81	393.9 - 448.1	366.9 - 475.1
2	151.30	5.33	140.9 - 161.8	130.4 - 172.2
3	803.80	25.84	753.2 - 854.4	702.5 - 905.1
7	1837.00	58.31	1722.7 - 1951.3	1608.4 - 2065.6
9	1531.00	48.70	1435.6 - 1626.4	1340.1 - 1721.9

*All sample concentrations are in mg NO_x/DSCM.

Using the previously defined performance ranges, a tabulation of all reported data (Table 17) reveals that 42% of those laboratories analyzing samples in survey 0577 measured none correctly within the sample range. In survey 1177 (Table 18), only 32% measured none correctly within the sample range.

TABLE 17. METHOD 7 SAMPLE RANGE CUMULATIVE DISTRIBUTION

No. of correctly measured samples	% Participants correct Survey 0577	Survey 1177
1	58	68
2	44	56
3	31	44
4	14	34
5	9	19

In survey 0577, 32% of the participants recorded none correctly measured within the target range, compared to only 16% of survey 1177.

TABLE 18. METHOD 7 TARGET RANGE CUMULATIVE DISTRIBUTION

No. of correctly measured samples	% Participants correct Survey 0577	Survey 1177
1	68	84
2	58	75
3	45	69
4	34	57
5	27	47

From Table 18 (Survey 0577), we find that 45% had three or more samples within the target range.

Frequency distributions (Tables 19 and 20) demonstrate that 50% of the results for all concentrations levels of Method 7, inclusive of both surveys, were less than or equal to an absolute percent difference of 15.14 and 7.41%, respectively. Note the magnitude of these values relative to the Method 6 results of 2.15 and 1.69% (Tables 7 and 8). Once again, the bottom line of each table examines the total data.

Tables 19 and 20 are useful for a participant's self-evaluation. For instance, a participant reporting a value for sample 1 (Table 19, Survey 0577)

significantly greater than 21% from the true value, should realize that 70% of the results were numerically closer.

All sample numbers were randomized with respect to concentration levels as with Method 6, and are grouped according to increasing concentration levels in Appendix B to allow participants to note their exact placement in the results.

Tables 21 through 24 tabulate summary statistics based on the total data and data where previously described outlier tests had removed spurious results.

Examination of Tables 21 through 24 justifies several observations. No method bias is evident. This is supported by low skewness, and similar median and mean values.

The accuracy values tend to indicate a small analytical bias between gravimetric "true values" and responses as a whole. Yet the scatter was so large, even when judged against the limits prescribed in the collaborative study, that one must conclude that the method is difficult to implement uniformly. However, good data was attainable as proven by the aforementioned 9 and 19% (Table 17) who correctly measured all five samples within the sample ranges. Therefore, the QAB will continue to examine the survey results in order to identify specific problems, so that the accuracy of users of Method 7 can be improved.

TABLE 19. METHOD 7 SURVEY 0577 - FREQUENCY DISTRIBUTION OF ABSOLUTE PERCENT DIFFERENCE

	No.	Min	10%	20%	30%	40%	50%	60%	70%	80%	90%	Max	Mean
# Within sample range	64	0	0	0	0	0	1	2	2	3	4	5	
# Within target range	64	0	0	0	0	1	2	3	4	5	5	5	
Sample 1	37	0.18	1.57	2.73	4.05	5.52	12.90	16.05	20.97	46.18	95.05	123.48	29.90
Sample 2	34	0.31	0.84	2.82	3.87	5.43	9.09	12.33	15.46	24.14	61.55	1338.35	59.64
Sample 3	40	0.04	1.88	5.11	7.66	8.82	15.14	21.42	35.06	50.88	79.40	116.95	29.77
Sample 4	36	0.15	0.68	2.13	4.27	8.13	13.56	20.48	23.66	42.60	48.24	105.81	24.27
Sample 6	44	1.37	2.86	3.98	9.75	14.12	20.31	39.50	48.06	89.84	98.99	279.28	44.76
Sample 7	46	0.25	0.48	4.43	5.17	6.45	8.99	16.75	25.80	52.93	98.97	111.26	30.31
Sample 8	42	1.60	2.50	5.27	6.81	14.42	20.48	33.20	46.15	86.36	98.98	117.15	38.85
Sample 9	39	0.10	0.63	2.19	3.34	4.91	15.99	24.87	49.74	78.47	98.96	131.97	36.17
All samples	318	0.04	1.88	3.87	5.55	8.99	15.14	20.98	42.60	61.55	98.98	1338.35	36.49

TABLE 20. METHOD 7 SURVEY 1177 - FREQUENCY DISTRIBUTION OF ABSOLUTE PERCENT DIFFERENCE

	No.	Min	10%	20%	30%	40%	50%	60%	70%	80%	90%	Max	Mean
# Within sample range	68	0	0	0	0	1	2	3	4	4	5	5	
# Within target range	68	0	0	1	2	3	4	5	5	5	5	5	
Sample 1	67	0.24	0.55	2.38	3.33	4.51	6.77	8.60	10.45	16.25	40.62	127.79	15.50
Sample 2	65	0.26	1.12	2.64	4.56	6.41	7.80	10.91	13.68	28.35	40.98	1083.08	34.32
Sample 3	67	0.37	1.02	1.83	2.95	4.76	6.56	9.57	13.41	16.37	67.43	124.68	19.14
Sample 7	68	0.53	1.02	2.66	3.70	4.93	6.80	9.80	13.34	19.22	42.84	129.07	16.61
Sample 9	67	0.13	0.76	1.92	3.01	5.86	9.16	10.74	13.29	17.90	36.04	136.71	16.00
All samples	334	0.13	1.24	2.21	3.83	5.29	7.41	10.19	13.41	20.07	44.89	1083.08	20.22

TABLE 21. METHOD 7 SURVEY 0577 - SUMMARY STATISTICS

Sample #	2	9	3	7	4	8	1	6
# of samples	34	39	40	46	36	42	37	44
True value*	95.70	95.70	669.80	669.80	1435.40	1435.40	1913.80	1913.80
Mean*	137.65	99.09	637.26	647.77	1388.01	1460.42	1888.08	1911.41
Median*	99.30	96.60	673.25	688.75	1451.75	1497.50	1883.70	1866.75
Std. dev.*	221.44	51.75	295.98	321.94	523.35	788.86	918.00	1328.66
% Coef. var.	160.87	52.22	46.45	49.70	38.35	54.02	48.62	69.51
Skewness	5.13	0.20	-0.08	0.05	-0.22	0.12	0.10	1.54
Accuracy	3.76	0.94	0.52	2.83	1.14	4.33	-1.57	-2.46

*All sample concentrations are in mg/DSCM.

TABLE 22. METHOD 7 SURVEY 0577 - SUMMARY STATISTICS (OUTLIERS REMOVED)

Sample #	2	9	3	7	4	8	1	6
# of samples	33	39	39	46	34	42	36	43
True value*	95.70	95.70	669.80	669.80	1435.40	1435.40	1913.80	1913.80
Mean*	100.12	99.09	616.35	647.77	1382.36	1460.42	1821.72	1787.06
Median*	99.20	96.60	669.50	688.75	1451.75	1497.50	1881.85	1859.00
Std. dev.*	33.99	51.75	268.23	321.94	411.07	788.86	836.19	1053.92
% Coef. var.	33.95	52.22	43.52	49.70	29.74	54.02	45.90	58.98
Skewness	0.22	0.20	-0.60	0.05	-1.00	0.12	-0.28	0.47
Accuracy	3.66	0.94	-0.04	2.83	1.14	4.33	-1.67	-2.86

*All sample concentrations are in mg/DSCM.

TABLE 23. METHOD 7 SURVEY 1177 - SUMMARY STATISTICS

Sample #	2	1	3	9	7
# of samples	65	67	67	67	68
True value*	151.30	421.00	803.80	1531.00	1837.00
Mean*	188.33	442.06	863.90	1597.47	1944.77
Median*	158.20	435.00	831.50	1577.10	1909.35
Std. dev.*	207.51	119.51	278.67	441.25	541.53
% Coef. var.	110.18	27.04	32.26	27.62	27.84
Skewness	7.08	1.83	1.10	2.03	1.13
Accuracy	4.56	3.33	3.45	3.01	3.94

*All sample concentrations are in mg/DSCM

TABLE 24. METHOD 7 SURVEY 1177 - SUMMARY STATISTICS (OUTLIERS REMOVED)

Sample #	2	1	3	9	7
# of samples	64	64	64	64	65
True value*	151.30	421.00	803.80	1531.00	1837.00
Mean*	163.30	422.77	823.99	1520.76	1913.84
Median*	158.20	434.25	828.75	1570.70	1905.00
Std. dev.*	48.85	79.06	212.20	258.44	370.94
% Coef. var.	29.91	18.70	25.75	16.99	19.38
Skewness	2.31	0.06	0.10	-1.49	1.04
Accuracy	4.56	3.15	3.10	2.59	3.70

*All sample concentrations are in mg/DSCM

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APPENDIX A

SO_2 SUMMARY DATA

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 1

N	50	RANGE	591.60	C.I.(UPPER)	286.47
TRUE-VALUE	266.91	VARIANCE	5412.73	C.I.(LOWE R)	245.69
MEAN	266.08	STD. DEV.	73.57	SKEWNESS	-.04
MEDIAN	268.35	COEF. VAR.	27.65	ACCURACY	.43

DATA IN ASCENDING ORDER

2.70	261.00	267.00	274.50	297.60
3.20	261.30	267.50	275.00	298.20
213.00	261.60	267.60	275.00	305.20
236.40	261.90	268.50	275.00	315.10
237.00	262.00	268.60	281.60	321.70
237.00	263.00	268.90	282.70	594.30
247.30	264.80	270.00	283.00	
253.30	266.10	270.70	284.10	
256.00	266.60	270.90	285.20	
256.70	266.90	271.10	294.40	
257.10	266.90	272.00	296.50	

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 1 **** WITH OUTLIERS REMOVED ****

N	47	RANGE	108.70	C.I.(UPPER)	275.98
TRUE-VALUE	266.91	VARIANCE	395.36	C.I.(LOWE R)	264.61
MEAN	270.29	STD. DEV.	19.88	SKEWNESS	.07
MEDIAN	268.50	COEF. VAR.	7.35	ACCURACY	.60

DATA IN ASCENDING ORDER

213.00	261.30	267.00	272.00	294.40
236.40	261.60	267.50	274.50	296.50
237.00	261.90	267.60	275.00	297.60
237.00	262.00	268.50	275.00	298.20
247.30	263.00	268.60	275.00	305.20
253.30	264.80	268.90	281.60	315.10
256.00	266.10	270.00	282.70	321.70
256.70	266.60	270.70	283.00	
257.10	266.90	270.90	284.10	
261.00	266.90	271.10	285.20	

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 2

N	53	RANGE	12256.30	C.I.(UPPER)	5419.99
TRUE-VALUE	5338.19	VARIANCE	3349096.28	C.I.(LOWER)	4434.59
MEAN	4927.29	STD. DEV.	1830.05	SKEWNESS	-.37
MEDIAN	5274.30	COEF. VAR.	37.14	ACCURACY	-1.20

DATA IN ASCENDING ORDER

53.70	5095.00	5262.10	5340.30	5439.00
67.00	5140.00	5262.50	5342.80	5447.50
162.60	5140.00	5268.40	5350.00	5481.00
291.50	5160.40	5274.20	5362.00	5489.80
429.60	5184.40	5274.30	5385.60	5554.80
4560.00	5209.00	5287.00	5390.00	5567.10
4559.60	5220.90	5300.00	5390.30	5589.00
4874.60	5221.70	5307.60	5392.10	5656.00
4904.60	5223.60	5330.00	5400.00	12320.00
5010.00	5238.10	5331.00	5407.60	
5089.40	5245.00	5331.50	5432.00	

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 2 **** WITH OUTLIERS REMOVED ****

N	52	RANGE	5202.30	C.I.(UPPER)	5199.34
TRUE-VALUE	5338.19	VARIANCE	2322544.59	C.I.(LOWER)	4370.89
MEAN	4785.12	STD. DEV.	1523.99	SKEWNESS	-2.58
MEDIAN	5274.25	COEF. VAR.	31.85	ACCURACY	-1.20

DATA IN ASCENDING ORDER

53.70	5095.00	5262.10	5340.30	5439.00
67.00	5140.00	5262.50	5342.80	5447.50
162.60	5140.00	5268.40	5350.00	5481.00
291.50	5160.40	5274.20	5362.00	5489.80
429.60	5184.40	5274.30	5385.60	5554.80
4560.00	5209.00	5287.00	5390.00	5567.10
4559.60	5220.90	5300.00	5390.30	5589.00
4874.60	5221.70	5307.60	5392.10	5656.00
4904.60	5223.60	5330.00	5400.00	
5010.00	5238.10	5331.00	5407.60	
5089.40	5245.00	5331.50	5432.00	

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INTER-LABORATORY STUDY 0577

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 3

N	51	RANGE	8607.50	C.I. (UPPER)	3978.27
TRUE-VALUE	3812.99	VARIANCE	1328488.14	C.I. (LOWE R)	3345.59
MEAN	3661.93	STD. DEV.	1152.60	SKEWNESS	.28
MEDIAN	3783.00	COEF. VAR.	31.48	ACCURACY	-.79

DATA IN ASCENDING ORDER

38.20	3680.00	3773.00	3808.50	3903.00
49.90	3680.60	3776.50	3811.90	3920.00
715.50	3721.30	3779.00	3814.80	3957.60
2703.60	3729.20	3783.00	3816.10	3965.70
3298.00	3744.90	3784.00	3820.00	4006.00
3340.20	3758.60	3790.00	3837.00	5205.30
3370.00	3761.00	3792.00	3844.40	8845.70
3502.30	3764.00	3793.10	3847.90	
3548.50	3766.50	3799.00	3857.20	
3659.00	3768.50	3800.00	3870.30	
3680.00	3770.00	3804.80	3902.70	

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 3 **** WITH OUTLIERS REMOVED ****

N	48	RANGE	4459.70	C.I. (UPPER)	3855.10
TRUE-VALUE	3812.99	VARIANCE	282703.15	C.I. (LOWE R)	3554.25
MEAN	3704.68	STD. DEV.	531.70	SKEWNESS	-3.38
MEDIAN	3783.50	COEF. VAR.	14.35	ACCURACY	-.77

DATA IN ASCENDING ORDER

715.50	3680.60	3773.00	3804.80	3870.30
2703.60	3721.30	3776.50	3808.50	3902.70
3298.00	3729.20	3779.00	3811.90	3903.00
3340.20	3744.90	3783.00	3814.80	3920.00
3370.00	3758.60	3784.00	3816.10	3957.60
3502.30	3761.00	3790.00	3820.00	3965.70
3548.50	3764.00	3792.00	3837.00	4006.00
3659.00	3766.50	3793.10	3844.40	5205.30
3680.00	3768.50	3799.00	3847.90	
3680.00	3770.00	3800.00	3857.20	

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 4

N	53	RANGE	5281.80	C.I.(UPPER)	2277.97
TRUE-VALUE	2097.15	VARIANCE	594335.23	C.I.(LOWE R)	1862.85
MEAN	2070.41	STD. DEV.	770.93	SKEWNESS	1.22
MEDIAN	2065.20	COEF. VAR.	37.24	ACCURACY	-.57

DATA IN ASCENDING ORDER

21.00	2022.30	2074.00	2100.00	2133.50
26.30	2030.00	2080.00	2100.00	2148.60
40.40	2032.60	2082.80	2102.00	2153.50
1828.00	2043.10	2083.00	2102.00	2161.30
1853.00	2054.80	2085.20	2103.40	2170.90
1879.90	2056.00	2086.00	2109.50	2176.00
1990.00	2060.00	2087.20	2109.90	2196.20
1992.00	2070.50	2087.70	2117.80	4845.70
2008.00	2072.00	2090.00	2118.00	5302.80
2021.50	2072.00	2098.00	2127.30	
2022.00	2073.90	2098.60	2131.80	

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 4 **** WITH OUTLIERS REMOVED ****

N	51	RANGE	2175.20	C.I.(UPPER)	2057.34
TRUE-VALUE	2097.15	VARIANCE	240644.44	C.I.(LOWE R)	1817.90
MEAN	1952.62	STD. DEV.	490.86	SKEWNESS	-3.51
MEDIAN	2063.00	COEF. VAR.	25.14	ACCURACY	-.67

DATA IN ASCENDING ORDER

21.00	2022.30	2074.00	2100.00	2133.50
26.30	2030.00	2080.00	2100.00	2148.60
40.40	2032.60	2082.80	2102.00	2153.50
1828.00	2043.10	2083.00	2102.00	2161.30
1853.00	2054.80	2085.20	2103.40	2170.90
1879.90	2056.00	2086.00	2109.50	2176.00
1990.00	2060.00	2087.20	2109.90	2196.20
1992.00	2070.50	2087.70	2117.80	
2008.00	2072.00	2090.00	2118.00	
2021.50	2072.00	2098.00	2127.30	
2022.00	2073.90	2098.60	2131.80	

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 6

N	45	RANGE	5247.00	C.I.(UPPER)	3855.33
TRUE-VALUE	3812.99	VARIANCE	679277.09	C.I.(LOWE R)	3373.71
MEAN	3614.52	STD. DEV.	824.15	SKEWNESS	-3.28
MEDIAN	3774.90	COEF. VAR.	22.80	ACCURACY	-1.00

DATA IN ASCENDING ORDER

76.30	3682.00	3768.50	3797.60	3900.00
115.00	3685.00	3771.00	3797.90	3920.00
2692.40	3686.30	3774.90	3822.00	3954.60
3566.90	3700.00	3776.20	3830.30	3984.70
3576.40	3728.30	3779.20	3837.30	5323.00
3589.70	3731.30	3782.60	3846.50	
3602.00	3738.20	3790.00	3848.30	
3620.00	3741.90	3790.30	3855.00	
3650.00	3746.80	3793.80	3872.40	
3665.10	3759.90	3794.20	3890.00	

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 6 **** WITH OUTLIERS REMOVED ****

N	43	RANGE	2630.60	C.I.(UPPER)	3870.07
TRUE-VALUE	3812.99	VARIANCE	94486.67	C.I.(LOWE R)	3686.32
MEAN	3778.20	STD. DEV.	307.39	SKEWNESS	1.91
MEDIAN	3776.20	COEF. VAR.	8.14	ACCURACY	-.96

DATA IN ASCENDING ORDER

2692.40	3685.00	3768.50	3794.20	3872.40
3566.90	3686.30	3771.00	3797.60	3890.00
3576.40	3700.00	3774.90	3797.90	3900.00
3589.70	3728.30	3776.20	3822.00	3920.00
3602.00	3731.30	3779.20	3830.30	3954.60
3620.00	3738.20	3782.60	3837.30	3984.70
3650.00	3741.90	3790.00	3846.50	5323.00
3665.10	3746.80	3790.30	3848.30	
3682.00	3759.90	3793.80	3855.00	

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 7

N	48	RANGE	12298.50	C.I.(UPPER)	5449.03
TRUE-VALUE	5338.19	VARIANCE	3532369.94	C.I.(LOWE R)	4395.63
MEAN	4917.33	STD. DEV.	1879.45	SKEWNESS	-.16
MEDIAN	5299.45	COEF. VAR.	38.22	ACCURACY	-.73

DATA IN ASCENDING ORDER

67.20	5125.40	5260.80	5343.70	5432.30
91.50	5139.90	5277.30	5348.60	5471.70
165.20	5149.00	5281.90	5359.00	5480.00
713.30	5199.20	5284.90	5360.50	5500.00
1040.40	5201.90	5314.00	5371.00	5552.00
3808.20	5204.70	5319.20	5384.10	5623.30
5000.70	5237.90	5321.20	5388.00	5661.00
5060.00	5239.80	5321.90	5389.50	12365.70
5079.00	5250.00	5338.90	5396.80	
5105.70	5250.70	5340.00	5415.00	

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 7 **** WITH OUTLIERS REMOVED ****

N	44	RANGE	4947.70	C.I.(UPPER)	5361.09
TRUE-VALUE	5338.19	VARIANCE	937159.43	C.I.(LOWE R)	4790.82
MEAN	5075.96	STD. DEV.	968.07	SKEWNESS	-3.79
MEDIAN	5316.60	COEF. VAR.	19.01	ACCURACY	-.40

DATA IN ASCENDING ORDER

713.30	5149.00	5277.30	5343.70	5415.00
1040.40	5199.20	5281.90	5348.60	5432.30
3808.20	5201.90	5284.90	5359.00	5471.70
5000.70	5204.70	5314.00	5360.50	5480.00
5060.00	5237.90	5319.20	5371.00	5500.00
5079.00	5239.80	5321.20	5384.10	5552.00
5105.70	5250.00	5321.90	5388.00	5623.30
5125.40	5250.70	5338.90	5389.50	5661.00
5139.90	5260.80	5340.00	5396.80	

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 8

N	48	RANGE	2156.50	C.I.(UPPER)	2059.19
TRUE-VALUE	2097.15	VARIANCE	303739.31	C.I.(LOWER)	1747.36
MEAN	1903.28	STD. DEV.	551.13	SKEWNESS	-2.78
MEDIAN	2085.85	COEF. VAR.	28.96	ACCURACY	-.54

DATA IN ASCENDING ORDER

21.20	2020.00	2082.00	2096.90	2127.20
42.30	2022.00	2083.50	2097.00	2136.30
64.50	2025.10	2083.60	2099.50	2143.80
422.70	2038.50	2085.70	2105.00	2154.30
1473.00	2043.20	2086.00	2105.40	2160.00
1842.00	2045.40	2087.50	2105.70	2162.70
1850.00	2062.60	2087.60	2108.00	2163.00
1968.50	2075.50	2089.60	2120.00	2177.70
1990.00	2080.00	2095.30	2123.40	
2002.00	2082.00	2095.50	2125.00	

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 8 **** WITH OUTLIERS REMOVED ****

N	44	RANGE	704.70	C.I.(UPPER)	2097.58
TRUE-VALUE	2097.15	VARIANCE	13075.95	C.I.(LOWER)	2030.01
MEAN	2063.80	STD. DEV.	114.35	SKEWNESS	-3.36
MEDIAN	2087.55	COEF. VAR.	5.54	ACCURACY	-.46

DATA IN ASCENDING ORDER

1473.00	2038.50	2083.60	2097.00	2127.20
1842.00	2043.20	2085.70	2099.50	2136.30
1850.00	2045.40	2086.00	2105.00	2143.80
1968.50	2062.60	2087.50	2105.40	2154.30
1990.00	2075.50	2087.60	2105.70	2160.00
2002.00	2080.00	2089.60	2108.00	2162.70
2020.00	2082.00	2095.30	2120.00	2163.00
2022.00	2082.00	2095.50	2123.40	2177.70
2025.10	2083.50	2096.90	2125.00	

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 9

N	49	RANGE	3769.00	C.I.(UPPER)	463.95
TRUE-VALUE	266.91	VARIANCE	258059.99	C.I.(LOWE R)	179.47
MEAN	321.71	STD. DEV.	508.01	SKEWNESS	6.39
MEDIAN	267.80	COEF. VAR.	157.91	ACCURACY	.33

DATA IN ASCENDING ORDER

4.60	258.90	265.00	271.80	285.00
8.10	258.90	265.00	273.30	286.00
49.30	259.00	265.70	273.70	289.50
61.40	259.20	267.20	274.00	292.00
198.50	260.00	267.80	274.30	293.00
250.90	262.60	268.40	274.50	298.20
253.30	263.80	269.00	275.00	298.20
257.00	264.00	269.40	275.10	302.00
258.30	264.30	270.50	276.00	3773.60
258.70	264.40	271.30	284.00	

INTER-LABORATORY STUDY 0577

POLLUTANT - SO2

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 9

**** WITH OUTLIERS REMOVED ****

N	48	RANGE	297.40	C.I.(UPPER)	269.30
TRUE-VALUE	266.91	VARIANCE	4756.62	C.I.(LOWE R)	230.28
MEAN	249.79	STD. DEV.	68.97	SKEWNESS	-2.72
MEDIAN	267.50	COEF. VAR.	27.61	ACCURACY	.22

DATA IN ASCENDING ORDER

4.60	258.90	265.00	271.30	285.00
8.10	258.90	265.00	273.30	286.00
49.30	259.00	265.70	273.70	289.50
61.40	259.20	267.20	274.00	292.00
198.50	260.00	267.80	274.30	293.00
250.90	262.60	268.40	274.50	298.20
253.30	263.80	269.00	275.00	298.20
257.00	264.00	269.40	275.10	302.00
258.30	264.30	270.50	276.00	
258.70	264.40	271.30	284.00	

INTER-LABORATORY STUDY 1177

POLLUTANT - SO2

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 2

N	84	RANGE	1425.80	C.I.(UPPER)	4342.33
TRUE-VALUE	4346.90	VARIANCE	31592.29	C.I.(LOWE R)	4266.31
MEAN	4304.32	STD. DEV.	177.74	SKEWNESS	.86
MEDIAN	4298.70	COEF. VAR.	4.13	ACCURACY	-1.11

DATA IN ASCENDING ORDER

3514.20	4246.30	4290.00	4319.50	4355.00
3982.70	4250.20	4290.00	4320.80	4357.40
4044.60	4255.40	4293.00	4321.10	4360.60
4093.00	4258.00	4293.00	4324.00	4366.30
4096.80	4259.00	4293.30	4324.00	4380.80
4121.00	4263.00	4293.50	4324.80	4381.00
4127.70	4266.10	4294.20	4325.00	4384.00
4148.50	4271.00	4297.20	4325.00	4412.20
4148.70	4272.00	4300.20	4326.00	4417.40
4200.20	4273.40	4301.20	4326.70	4418.30
4200.40	4275.00	4305.00	4328.00	4449.40
4207.70	4277.00	4306.60	4330.00	4477.00
4229.60	4279.00	4307.30	4340.50	4543.10
4232.50	4280.00	4308.00	4341.20	4834.00
4236.00	4285.00	4310.80	4342.30	4920.00
4236.40	4285.20	4313.40	4342.90	5140.00
4238.30	4290.00	4318.60	4345.40	

INTER-LABORATORY STUDY 1177

POLLUTANT - SO2

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 2

**** WITH OUTLIERS REMOVED ****

N	80	RANGE	560.40	C.I.(UPPER)	4308.88
TRUE-VALUE	4346.90	VARIANCE	7275.44	C.I.(LOWE R)	4269.99
MEAN	4289.43	STD. DEV.	85.74	SKEWNESS	-.67
MEDIAN	4295.70	COEF. VAR.	2.07	ACCURACY	-1.18

DATA IN ASCENDING ORDER

3982.70	4250.20	4290.00	4320.80	4357.40
4044.60	4255.40	4293.00	4321.10	4360.60
4093.00	4258.00	4293.00	4324.00	4366.30
4096.80	4259.00	4293.30	4324.00	4380.80
4121.00	4263.00	4293.50	4324.80	4381.00
4127.70	4266.10	4294.20	4325.00	4384.00
4148.50	4271.00	4297.20	4325.00	4412.20
4148.70	4272.00	4300.20	4326.00	4417.40
4200.20	4273.40	4301.20	4326.70	4418.30
4200.40	4275.00	4305.00	4328.00	4449.40
4207.70	4277.00	4306.60	4330.00	4477.00
4229.60	4279.00	4307.30	4340.50	4543.10
4232.50	4280.00	4308.00	4341.20	
4236.00	4285.00	4310.80	4342.30	
4236.40	4285.20	4313.40	4342.90	
4238.30	4290.00	4318.60	4345.40	
4246.30	4290.00	4319.50	4355.00	

INTER-LABORATORY STUDY 1177

POLLUTANT - SO2

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 4

N	83	RANGE	1946.30	C.I.(UPPER)	5119.01
TRUE-VALUE	5147.60	VARIANCE	48522.73	C.I.(LOWE R)	5024.23
MEAN	5071.62	STD. DEV.	220.28	SKEWNESS	-.09
MEDIAN	5085.70	COEF. VAR.	4.34	ACCURACY	-1.20

DATA IN ASCENDING ORDER

4148.70	5010.00	5072.00	5102.20	5148.10
4210.00	5015.00	5073.00	5102.60	5149.40
4770.00	5016.90	5074.20	5103.20	5156.40
4795.90	5018.00	5077.30	5103.80	5161.00
4817.30	5027.30	5078.10	5107.00	5166.50
4850.30	5028.20	5081.70	5108.80	5168.00
4873.00	5030.00	5083.00	5109.20	5173.00
4911.00	5033.00	5085.70	5117.20	5185.00
4916.10	5037.00	5089.00	5119.00	5201.00
4920.30	5039.40	5091.30	5119.00	5250.60
4941.50	5039.40	5093.00	5122.70	5302.00
4955.00	5056.00	5093.50	5123.60	5305.10
4962.00	5059.00	5094.30	5130.00	5529.30
4987.50	5059.40	5096.50	5135.00	5688.00
5001.00	5064.20	5098.00	5140.00	6095.00
5004.40	5066.00	5099.20	5140.00	
5007.70	5071.40	5100.00	5140.60	

INTER-LABORATORY STUDY 1177

POLLUTANT - SO2

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 4 **** WITH OUTLIERS REMOVED ****

N	79	RANGE	759.30	C.I.(UPPER)	5097.88
TRUE-VALUE	5147.60	VARIANCE	12271.79	C.I.(LOWE R)	5049.02
MEAN	5073.45	STD. DEV.	110.78	SKEWNESS	.28
MEDIAN	5085.70	COEF. VAR.	2.18	ACCURACY	-1.20

DATA IN ASCENDING ORDER

4770.00	5015.00	5072.00	5100.00	5140.00
4795.90	5016.90	5073.00	5102.20	5140.60
4817.30	5018.00	5074.20	5102.60	5148.10
4850.30	5027.30	5077.30	5103.20	5149.40
4873.00	5028.20	5078.10	5103.80	5156.40
4911.00	5030.00	5081.70	5107.00	5161.00
4916.10	5033.00	5083.00	5108.80	5166.50
4920.30	5037.00	5085.70	5109.20	5168.00
4941.50	5039.40	5089.00	5117.20	5173.00
4955.00	5039.40	5091.30	5119.00	5185.00
4962.00	5056.00	5093.00	5119.00	5201.00
4987.50	5059.00	5093.50	5122.70	5250.60
5001.00	5059.40	5094.30	5123.60	5302.00
5004.40	5064.20	5096.50	5130.00	5305.10
5007.70	5066.00	5098.00	5135.00	5529.30
5010.00	5071.40	5099.20	5140.00	

INTER-LABORATORY STUDY 1177

POLLUTANT - SO2

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 5

N	83	RANGE	544.90	C.I.(UPPER)	152.98
TRUE-VALUE	137.30	VARIANCE	3006.51	C.I.(LOWER)	135.39
MEAN	147.19	STD. DEV.	54.83	SKEWNESS	5.73
MEDIAN	138.70	COEF. VAR.	37.25	ACCURACY	1.02

DATA IN ASCENDING ORDER

29.10	133.50	137.30	140.20	149.50
91.60	133.60	137.30	140.50	150.00
100.70	133.60	137.90	140.50	151.30
105.00	134.10	138.30	140.60	154.40
117.10	134.20	138.30	140.80	157.00
120.00	134.50	138.50	140.90	158.00
124.30	135.00	138.60	141.00	166.00
127.60	135.00	138.70	141.60	169.80
128.10	135.00	138.70	141.70	176.30
130.00	135.00	138.80	141.90	196.60
131.00	135.70	139.40	142.00	220.00
131.50	135.80	139.80	142.80	220.00
131.70	135.90	140.00	143.00	243.30
132.00	135.90	140.00	144.00	248.00
132.40	136.40	140.00	144.80	574.00
132.90	137.00	140.10	148.70	
133.50	137.30	140.20	149.30	

INTER-LABORATORY STUDY 1177

POLLUTANT - SO2

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 5

**** WITH OUTLIERS REMOVED ****

N	82	RANGE	218.90	C.I.(UPPER)	147.98
TRUE-VALUE	137.30	VARIANCE	767.18	C.I.(LOWER)	135.99
MEAN	141.98	STD. DEV.	27.70	SKEWNESS	.97
MEDIAN	138.65	COEF. VAR.	19.51	ACCURACY	.98

DATA IN ASCENDING ORDER

29.10	133.50	137.30	140.20	149.50
91.60	133.60	137.30	140.50	150.00
100.70	133.60	137.90	140.50	151.30
105.00	134.10	138.30	140.60	154.40
117.10	134.20	138.30	140.80	157.00
120.00	134.50	138.50	140.90	158.00
124.30	135.00	138.60	141.00	166.00
127.60	135.00	138.70	141.60	169.80
128.10	135.00	138.70	141.70	176.30
130.00	135.00	138.80	141.90	196.60
131.00	135.70	139.40	142.00	220.00
131.50	135.80	139.80	142.80	220.00
131.70	135.90	140.00	143.00	243.30
132.00	135.90	140.00	144.00	246.00
132.40	136.40	140.00	144.80	
132.90	137.00	140.10	148.70	
133.50	137.30	140.20	149.30	

INTER-LABORATORY STUDY 1177

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 7

N	85	RANGE	734.10	C.I.(UPPER)	1410.61
TRUE-VALUE	1410.90	VARIANCE	6144.57	C.I.(LOWER)	1377.29
MEAN	1393.95	STD. DEV.	78.39	SKEWNESS	2.63
MEDIAN	1391.70	COEF. VAR.	5.62	ACCURACY	-1.36

DATA IN ASCENDING ORDER

1140.90	1372.90	1388.00	1397.90	1416.00
1220.00	1373.00	1388.00	1396.00	1422.00
1257.00	1374.00	1390.00	1399.40	1425.00
1297.80	1375.20	1390.10	1400.00	1425.10
1311.70	1376.40	1390.20	1400.90	1427.40
1317.80	1376.80	1391.20	1401.00	1435.20
1320.00	1377.00	1391.70	1401.80	1441.50
1327.60	1377.20	1392.00	1402.00	1446.00
1342.20	1377.30	1392.60	1405.20	1448.40
1345.50	1379.70	1393.60	1405.30	1503.60
1348.00	1380.00	1394.00	1406.50	1556.00
1353.50	1381.60	1394.10	1410.00	1652.00
1363.40	1383.00	1395.30	1410.00	1875.00
1367.00	1383.00	1395.60	1410.00	
1369.60	1383.90	1395.60	1410.30	
1370.00	1385.50	1396.00	1416.60	
1371.60	1386.40	1396.30	1416.60	
1372.60	1387.20	1397.00	1417.30	

INTER-LABORATORY STUDY 1177

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 7 **** WITH OUTLIERS REMOVED ****

N	82	RANGE	338.00	C.I.(UPPER)	1397.37
TRUE-VALUE	1410.90	VARIANCE	1867.09	C.I.(LOWER)	1376.67
MEAN	1388.02	STD. DEV.	43.21	SKEWNESS	-.28
MEDIAN	1391.45	COEF. VAR.	3.11	ACCURACY	-1.38

DATA IN ASCENDING ORDER

1220.00	1372.90	1387.20	1396.30	1416.60
1257.00	1373.00	1388.00	1397.00	1416.60
1297.80	1374.00	1388.00	1397.90	1417.30
1311.70	1375.20	1390.00	1398.00	1416.00
1317.80	1376.40	1390.10	1399.40	1422.00
1320.00	1376.80	1390.20	1400.00	1425.00
1327.60	1377.00	1391.20	1400.90	1425.10
1342.20	1377.20	1391.70	1401.00	1427.40
1345.50	1377.30	1392.00	1401.80	1435.20
1348.00	1379.70	1392.60	1402.00	1441.50
1353.50	1380.00	1393.60	1405.20	1448.00
1363.40	1381.60	1394.00	1405.30	1448.40
1367.00	1383.00	1394.10	1406.50	1503.60
1369.60	1383.00	1395.30	1410.00	1556.00
1370.00	1383.90	1395.60	1410.00	
1371.60	1385.50	1395.60	1410.00	
1372.60	1386.40	1396.00	1410.30	

INTER-LABORATORY STUDY 1177

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 8

N	84	RANGE	942.50	C.I.(UPPER)	2587.81
TRUE-VALUE	2592.90	VARIANCE	9010.41	C.I.(LOWER)	2547.21
MEAN	2567.51	STD. DEV.	94.92	SKEWNESS	.24
MEDIAN	2562.80	COEF. VAR.	3.70	ACCURACY	-1.17

DATA IN ASCENDING ORDER

2086.50	2526.70	2558.00	2572.00	2605.20
2420.00	2532.10	2559.40	2573.70	2608.80
2440.00	2534.40	2559.00	2575.00	2608.90
2458.40	2534.50	2559.30	2577.30	2613.10
2474.00	2534.80	2560.00	2578.00	2615.20
2489.20	2536.90	2560.00	2580.00	2619.60
2490.40	2539.50	2561.10	2582.40	2621.00
2511.00	2540.00	2562.40	2584.00	2627.70
2514.00	2543.00	2562.80	2584.60	2635.00
2514.00	2546.00	2563.00	2586.00	2644.80
2516.60	2548.40	2564.00	2592.00	2662.00
2517.00	2548.70	2564.30	2592.90	2678.30
2517.80	2548.90	2564.70	2594.40	2682.00
2518.20	2551.00	2566.00	2596.50	2732.30
2518.50	2551.40	2570.00	2596.70	2879.00
2525.00	2551.40	2570.80	2605.00	3029.00
2526.10	2554.40	2570.90	2605.00	

INTER-LABORATORY STUDY 1177

POLLUTANT - SO2 UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 8 **** WITH OUTLIERS REMOVED ****

N	81	RANGE	312.30	C.I.(UPPER)	2574.94
TRUE-VALUE	2592.90	VARIANCE	2566.05	C.I.(LOWER)	2552.87
MEAN	2563.91	STD. DEV.	50.65	SKEWNESS	.22
MEDIAN	2562.40	COEF. VAR.	1.98	ACCURACY	-1.18

DATA IN ASCENDING ORDER

2420.00	2532.10	2558.40	2573.70	2608.80
2440.00	2534.40	2559.00	2575.00	2608.90
2458.40	2534.50	2559.30	2577.30	2613.10
2474.00	2534.80	2560.00	2578.00	2615.20
2489.20	2536.90	2560.00	2580.00	2619.60
2490.40	2539.50	2561.10	2582.40	2621.00
2511.00	2540.00	2562.40	2584.00	2627.70
2514.00	2543.00	2562.80	2584.60	2635.00
2514.00	2546.00	2563.00	2586.00	2644.80
2516.60	2548.40	2564.00	2592.00	2662.00
2517.00	2548.70	2564.30	2592.90	2678.30
2517.80	2548.90	2564.70	2594.40	2682.00
2518.20	2551.00	2566.00	2596.50	2732.30
2518.50	2551.40	2570.00	2596.70	
2525.00	2551.40	2570.80	2605.00	
2526.10	2554.40	2570.90	2605.00	
2526.70	2558.00	2572.00	2605.20	

APPENDIX B

NO_x SUMMARY DATA

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 1

N	37	RANGE	4270.10	C.I.(UPPER)	2183.28
TRUE-VALUE	1913.80	VARIANCE	842723.21	C.I.(LOWE R)	1502.28
MEAN	1868.08	STD. DEV.	918.00	SKEWNESS	.10
MEDIAN	1893.70	COEF. VAR.	48.62	ACCURACY	-1.57

DATA IN ASCENDING ORDER

6.90	1666.00	1874.50	2016.00	2587.50
17.10	1667.00	1880.00	2046.60	2982.70
18.20	1750.30	1883.70	2052.60	3675.00
205.00	1808.10	1910.30	2188.50	3834.50
1030.00	1846.00	1939.00	2197.00	4277.00
1164.20	1853.50	1966.00	2252.70	
1305.00	1860.00	1991.30	2315.00	
1606.60	1863.30	2006.90	2315.10	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 1

**** WITH OUTLIERS REMOVED ****

N	36	RANGE	3827.60	C.I.(UPPER)	2094.88
TRUE-VALUE	1913.80	VARIANCE	699216.84	C.I.(LOWE R)	1548.57
MEAN	1821.72	STD. DEV.	836.19	SKEWNESS	-.28
MEDIAN	1861.85	COEF. VAR.	45.90	ACCURACY	-1.67

DATA IN ASCENDING ORDER

6.90	1666.00	1874.50	2016.00	2587.50
17.10	1667.00	1880.00	2046.60	2982.70
18.20	1750.30	1883.70	2052.60	3675.00
205.00	1808.10	1910.30	2188.50	3834.50
1030.00	1846.00	1939.00	2197.00	
1164.20	1853.50	1966.00	2252.70	
1305.00	1860.00	1991.30	2315.00	
1606.60	1863.30	2006.90	2315.10	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 2

N	34	RANGE	1375.60	C.I.(UPPER)	212.09
TRUE-VALUE	95.70	VARIANCE	49036.52	C.I.(LOWER)	63.22
MEAN	137.66	STD. DEV.	221.44	SKEWNESS	5.13
MEDIAN	99.30	COEF. VAR.	160.87	ACCURACY	3.76

DATA IN ASCENDING ORDER

.90	89.40	96.50	104.00	117.10
43.90	92.00	97.30	104.40	118.80
50.00	92.50	99.20	107.50	154.60
76.30	93.00	99.40	109.10	183.50
84.00	93.80	100.00	109.50	194.00
87.00	96.00	100.30	110.50	1376.50
88.50	96.00	100.90	113.90	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 2

**** WITH OUTLIERS REMOVED ****

N	33	RANGE	193.10	C.I.(UPPER)	111.71
TRUE-VALUE	95.70	VARIANCE	1155.11	C.I.(LOWER)	88.52
MEAN	100.12	STD. DEV.	33.99	SKEWNESS	.22
MEDIAN	99.20	COEF. VAR.	33.95	ACCURACY	3.66

DATA IN ASCENDING ORDER

.90	89.40	96.50	104.00	117.10
43.90	92.00	97.30	104.40	118.80
50.00	92.50	99.20	107.50	154.60
76.30	93.00	99.40	109.10	183.50
84.00	93.80	100.00	109.50	194.00
87.00	96.00	100.30	110.50	
88.50	96.00	100.90	113.90	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 3

N	40	RANGE	1466.50	C.I.(UPPER)	728.99
TRUE-VALUE	669.50	VARIANCE	87605.61	C.I.(LOWER)	545.54
MEAN	637.26	STD. DEV.	295.98	SKEWNESS	-.08
MEDIAN	673.25	COEF. VAR.	46.45	ACCURACY	.52

DATA IN ASCENDING ORDER

6.50	559.70	662.00	726.00	1010.60
6.90	568.40	669.50	730.00	1100.00
76.90	602.90	677.00	748.20	1180.00
138.00	610.70	685.00	787.50	1453.10
180.40	611.00	697.90	803.60	
332.90	614.00	704.00	813.30	
367.50	630.00	706.80	824.50	
360.00	647.00	707.00	827.80	
435.00	657.20	721.10	829.70	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 3

**** WITH OUTLIERS REMOVED ****

N	39	RANGE	1173.40	C.I.(UPPER)	700.53
TRUE-VALUE	669.50	VARIANCE	71946.47	C.I.(LOWER)	532.16
MEAN	616.35	STD. DEV.	268.23	SKEWNESS	-.60
MEDIAN	669.50	COEF. VAR.	43.52	ACCURACY	-.04

DATA IN ASCENDING ORDER

6.50	435.00	647.00	706.80	813.30
6.90	559.70	657.20	707.00	824.50
76.90	568.40	662.00	721.10	827.80
138.00	602.90	669.50	726.00	829.70
180.40	610.70	677.00	730.00	1010.60
332.90	611.00	685.00	748.20	1100.00
367.50	614.00	697.90	787.50	1180.00
360.00	630.00	704.00	803.60	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 4

N	36	RANGE	2940.40	C.I.(UPPER)	1561.91
TRUE-VALUE	1435.40	VARIANCE	283395.71	C.I.(LOWE R)	1214.11
MEAN	1388.01	STD. DEV.	532.35	SKEWNESS	-.22
MEDIAN	1451.75	COEF. VAR.	38.35	ACCURACY	1.14

DATA IN ASCENDING ORDER

13.80	1141.20	1426.00	1552.10	1796.30
154.90	1292.30	1437.50	1600.00	2046.90
523.00	1296.80	1466.00	1630.00	2059.30
743.00	1356.00	1484.50	1645.80	2954.20
790.00	1405.00	1496.70	1702.20	
810.00	1409.00	1498.30	1729.30	
901.70	1415.70	1533.00	1749.80	
1138.90	1425.70	1533.50	1775.00	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 4

**** WITH OUTLIERS REMOVED ****

N	34	RANGE	1904.40	C.I.(UPPER)	1520.54
TRUE-VALUE	1435.40	VARIANCE	168980.70	C.I.(LOWE R)	1244.19
MEAN	1382.36	STD. DEV.	411.07	SKEWNESS	-1.00
MEDIAN	1451.75	COEF. VAR.	29.74	ACCURACY	1.14

DATA IN ASCENDING ORDER

154.90	1141.20	1425.70	1533.00	1729.30
528.00	1292.30	1426.00	1533.50	1749.80
743.00	1296.80	1437.50	1552.10	1775.00
790.00	1356.00	1466.00	1600.00	1796.30
810.00	1405.00	1484.50	1630.00	2046.90
901.70	1409.00	1496.70	1645.80	2059.30
1138.90	1415.70	1498.30	1702.20	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 6

N	44	RANGE	7253.20	C.I.(UPPER)	2304.01
TRUE-VALUE	1913.80	VARIANCE	1765347.05	C.I.(LOWE R)	1518.82
MEAN	1911.41	STD. DEV.	1328.66	SKEWNESS	1.54
MEDIAN	1866.75	COEF. VAR.	69.51	ACCURACY	-2.46

DATA IN ASCENDING ORDER

5.50	998.00	1746.00	2006.00	2491.30
19.20	1049.00	1845.00	2051.30	2669.80
19.40	1075.00	1850.00	2090.00	3090.00
181.80	1355.00	1859.00	2136.40	3635.00
194.50	1490.00	1874.50	2161.90	3680.00
284.20	1533.70	1877.00	2219.00	3937.80
762.00	1643.50	1940.00	2290.00	4836.00
974.10	1677.00	1982.00	2300.00	7258.70
994.00	1727.20	1989.90	2302.50	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 6

**** WITH OUTLIERS REMOVED ****

N	43	RANGE	4830.50	C.I.(UPPER)	2102.07
TRUE-VALUE	1913.80	VARIANCE	1110749.70	C.I.(LOWE R)	1472.04
MEAN	1787.06	STD. DEV.	1053.92	SKEWNESS	.47
MEDIAN	1859.00	COEF. VAR.	58.98	ACCURACY	-2.66

DATA IN ASCENDING ORDER

5.50	998.00	1746.00	2006.00	2491.30
19.20	1049.00	1845.00	2051.30	2669.80
19.40	1075.00	1850.00	2090.00	3090.00
181.80	1355.00	1859.00	2136.40	3635.00
194.50	1490.00	1874.50	2161.90	3680.00
284.20	1533.70	1877.00	2219.00	3937.80
762.00	1643.50	1940.00	2290.00	4836.00
974.10	1677.00	1982.00	2300.00	
994.00	1727.20	1989.90	2302.50	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 7

N	46	RANGE	1413.10	C.I.(UPPER)	740.80
TRUE-VALUE	669.80	VARIANCE	10346.84	C.I.(LOWE R)	554.73
MEAN	647.77	STD. DEV.	321.94	SKEWNESS	-.05
MEDIAN	688.75	COEF. VAR.	49.70	ACCURACY	2.83

DATA IN ASCENDING ORDER

1.90	545.10	673.00	713.00	820.00
5.90	600.00	675.00	714.00	882.60
6.70	617.00	678.00	730.00	1300.00
6.90	632.60	699.50	730.00	1303.00
78.50	635.20	700.00	730.00	1395.00
268.00	643.00	702.30	745.70	1415.00
315.30	649.00	704.00	760.50	
336.50	667.00	704.60	782.00	
376.70	668.10	710.70	783.30	
497.00	673.00	712.30	810.30	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 7

**** WITH OUTLIERS REMOVED ****

N	46	RANGE	1413.10	C.I.(UPPER)	740.80
TRUE-VALUE	669.80	VARIANCE	10346.84	C.I.(LOWE R)	554.73
MEAN	647.77	STD. DEV.	321.94	SKEWNESS	-.05
MEDIAN	688.75	COEF. VAR.	49.70	ACCURACY	2.83

DATA IN ASCENDING ORDER

1.90	545.10	673.00	713.00	820.00
5.90	600.00	675.00	714.00	882.60
6.70	617.00	678.00	730.00	1300.00
6.90	632.60	699.50	730.00	1303.00
78.50	635.20	700.00	730.00	1395.00
268.00	643.00	702.30	745.70	1415.00
315.30	649.00	704.00	760.50	
336.50	667.00	704.60	782.00	
376.70	668.10	710.70	783.30	
497.00	673.00	712.30	810.30	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 8

N	42	RANGE	3112.60	C.I.(UPPER)	1699.00
TRUE-VALUE	1435.40	VARIANCE	622299.82	C.I.(LOWE R)	1221.64
MEAN	1460.42	STD. DEV.	788.86	SKEWNESS	.12
MEDIAN	1497.50	COEF. VAR.	54.02	ACCURACY	4.33

DATA IN ASCENDING ORDER

4.20	958.60	1469.10	1642.40	2269.20
13.60	1143.00	1471.30	1662.00	2675.00
14.70	1205.00	1495.00	1690.00	2773.00
110.40	1291.00	1500.00	1729.30	3070.00
154.60	1313.00	1500.00	1799.40	3109.60
579.00	1337.60	1511.00	1805.00	3117.00
747.00	1341.00	1512.00	1810.60	
773.00	1412.50	1532.10	1946.00	
819.00	1460.00	1574.90	1996.40	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

**** WITH OUTLIERS REMOVED ****

SAMPLE NUMBER - 8

N	42	RANGE	3112.60	C.I.(UPPER)	1699.00
TRUE-VALUE	1435.40	VARIANCE	622299.82	C.I.(LOWE R)	1221.64
MEAN	1460.42	STD. DEV.	788.86	SKEWNESS	.12
MEDIAN	1497.50	COEF. VAR.	54.02	ACCURACY	4.33

DATA IN ASCENDING ORDER

4.20	958.60	1469.10	1642.40	2269.20
13.60	1143.00	1471.30	1662.00	2675.00
14.70	1205.00	1495.00	1690.00	2773.00
110.40	1291.00	1500.00	1729.30	3070.00
154.60	1313.00	1500.00	1799.40	3109.60
579.00	1337.60	1511.00	1805.00	3117.00
747.00	1341.00	1512.00	1810.60	
773.00	1412.50	1532.10	1946.00	
819.00	1460.00	1574.90	1996.40	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 9

N	39	RANGE	221.10	C.I.(UPPER)	115.34
TRUE-VALUE	95.70	VARIANCE	2677.69	C.I.(LOWER)	82.85
MEAN	99.09	STD. DEV.	51.75	SKEWNESS	.20
MEDIAN	96.60	COEF. VAR.	52.22	ACCURACY	.94

DATA IN ASCENDING ORDER

.90	76.40	95.80	100.30	133.10
1.00	86.60	96.00	100.40	158.00
1.20	90.00	96.30	106.00	181.00
20.60	92.00	96.60	111.00	188.20
36.00	92.50	97.80	111.00	192.00
44.00	93.60	98.00	118.50	193.80
48.10	93.70	98.90	119.50	222.00
52.00	93.90	100.00	128.00	

INTER-LABORATORY STUDY 0577

POLLUTANT - NOX UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 9 **** WITH OUTLIERS REMOVED ****

N	39	RANGE	221.10	C.I.(UPPER)	115.34
TRUE-VALUE	95.70	VARIANCE	2677.89	C.I.(LOWER)	82.85
MEAN	99.09	STD. DEV.	51.75	SKEWNESS	.20
MEDIAN	96.60	COEF. VAR.	52.22	ACCURACY	.94

DATA IN ASCENDING ORDER

.90	76.40	95.80	100.30	133.10
1.00	86.60	96.00	100.40	158.00
1.20	90.00	96.30	106.00	181.00
20.60	92.00	96.60	111.00	188.20
36.00	92.50	97.80	111.00	192.00
44.00	93.60	98.00	118.50	193.80
48.10	93.70	98.90	119.50	222.00
52.00	93.90	100.00	128.00	

INTER-LABORATORY STUDY 1177

POLLUTANT - NOX UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 1

N	67	RANGE	749.00	C.I.(UPPER)	470.68
TRUE-VALUE	421.00	VARIANCE	14283.48	C.I.(LOWER)	413.44
MEAN	442.06	STD. DEV.	119.51	SKEWNESS	1.82
MEDIAN	435.00	COEF. VAR.	27.04	ACCURACY	5.33

DATA IN ASCENDING ORDER

210.00	408.00	431.00	449.50	471.40
229.00	409.50	433.00	450.00	475.60
232.00	412.90	434.00	450.30	485.00
250.00	415.30	434.00	451.60	488.40
251.90	419.70	434.50	452.20	489.40
268.70	420.00	435.00	455.60	505.50
326.00	422.50	438.00	456.00	508.30
326.60	422.60	438.80	457.20	761.00
375.50	423.00	439.00	457.40	782.70
363.50	423.30	439.70	461.80	818.70
397.00	427.20	440.00	461.80	959.00
400.00	428.00	442.20	462.50	
400.40	428.40	445.00	465.00	
404.00	429.90	446.00	466.70	

INTER-LABORATORY STUDY 1177

POLLUTANT - NOX UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 1 **** WITH OUTLIERS REMOVED ****

N	64	RANGE	751.00	C.I.(UPPER)	442.14
TRUE-VALUE	421.00	VARIANCE	6250.52	C.I.(LOWER)	403.40
MEAN	422.77	STD. DEV.	79.06	SKEWNESS	.06
MEDIAN	434.25	COEF. VAR.	18.70	ACCURACY	3.15

DATA IN ASCENDING ORDER

210.00	404.00	428.40	442.20	461.80
229.00	408.00	429.90	445.00	462.50
232.00	409.50	431.00	446.00	465.00
250.00	412.90	433.00	449.50	466.70
251.90	415.30	434.00	450.00	471.40
268.70	419.70	434.00	450.30	475.60
326.00	420.00	434.50	451.60	485.00
326.60	422.50	435.00	452.20	488.40
375.50	422.60	438.00	455.60	489.40
363.50	423.00	438.80	456.00	505.50
397.00	423.30	439.00	457.20	508.30
400.00	427.20	439.70	457.40	761.00
400.40	428.00	440.00	461.80	

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INTER-LABORATORY STUDY 1177

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 2

N	65	RANGE	1914.30	C.I.(UPPER)	238.78
TRUE-VALUE	151.30	VARIANCE	43058.94	C.I.(LOWE R)	137.88
MEAN	188.33	STD. DEV.	207.51	SKEWNESS	7.08
MEDIAN	158.20	COEF. VAR.	110.15	ACCURACY	4.56

DATA IN ASCENDING ORDER

75.70	146.60	155.5[illegible]	163.10	186.90
87.40	147.30	157.5[illegible]	166.30	194.20
89.40	148.00	157.70	166.60	206.80
95.00	148.90	158.20	167.80	213.30
96.50	150.00	158.20	168.00	234.00
97.00	150.00	158.50	170.00	308.90
131.40	151.70	159.30	171.00	315.20
135.00	153.00	161.00	171.00	396.00
136.00	153.60	161.00	172.00	1790.00
138.00	153.00	161.40	172.60	
138.00	153.40	161.7[illegible]	173.20	
142.00	153.60	161.8[illegible]	173.60	
144.00	153.90	162.00	176.60	
145.50	154.00	162.50	179.90	

INTER-LABORATORY STUDY 1177

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 2

**** WITH OUTLIERS REMOVED ****

N	64	RANGE	220.30	C.I.(UPPER)	175.27
TRUE-VALUE	151.30	VARIANCE	2386.34	C.I.(LOWE R)	151.32
MEAN	163.30	STD. DEV.	48.85	SKEWNESS	2.31
MEDIAN	158.20	COEF. VAR.	29.91	ACCURACY	4.56

DATA IN ASCENDING ORDER

75.70	145.50	153.90	161.80	173.20
87.40	146.60	154.00	162.00	173.60
89.40	147.30	155.50	162.50	176.60
95.00	148.00	157.50	163.10	179.90
96.50	148.90	157.70	166.30	186.90
97.00	150.00	158.20	166.60	194.20
131.40	150.00	158.20	167.80	206.80
135.00	151.70	158.50	168.00	213.30
136.00	153.00	159.30	170.00	234.00
138.00	153.00	161.00	171.00	308.90
138.00	153.00	161.00	171.00	315.20
142.00	153.40	161.40	172.00	396.00
144.00	153.60	161.7[illegible]	172.60	

INTER-LABORATORY STUDY 1177

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 3

N	67	RANGE	1030.00	C.I.(UPPER)	920.63
TRUE-VALUE	803.80	VARIANCE	7757.94	C.I.(LOWER)	797.17
MEAN	863.90	STD. DEV.	278.67	SKEWNESS	1.10
MEDIAN	831.50	COEF. VAR.	32.25	ACCURACY	3.45

DATA IN ASCENDING ORDER

156.00	788.60	820.00	858.00	926.50
160.00	789.10	822.60	865.00	932.20
423.00	790.30	827.00	867.00	932.50
470.00	797.50	827.50	871.00	935.40
493.80	800.60	830.00	875.90	1004.00
521.80	810.00	831.50	880.70	1345.60
553.30	810.80	833.00	881.00	1500.00
578.70	812.00	840.00	885.40	1540.00
752.00	812.00	843.00	891.20	1655.00
760.00	814.00	844.80	901.00	1684.50
765.50	814.00	853.70	902.00	1806.00
767.00	815.00	854.50	911.60	
781.00	816.00	856.50	917.20	
783.00	817.50	857.40	917.70	

INTER-LABORATORY STUDY 1177

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 3

**** WITH OUTLIERS REMOVED ****

N	64	RANGE	1294.00	C.I.(UPPER)	875.98
TRUE-VALUE	803.80	VARIANCE	4527.41	C.I.(LOWER)	772.01
MEAN	823.99	STD. DEV.	212.20	SKEWNESS	.10
MEDIAN	828.75	COEF. VAR.	25.75	ACCURACY	3.10

DATA IN ASCENDING ORDER

156.00	783.00	816.00	854.50	902.00
160.00	788.60	817.50	856.50	911.60
423.00	789.10	820.00	857.40	917.20
470.00	790.30	822.60	858.00	917.70
493.80	797.50	827.00	865.00	926.50
521.80	800.60	827.50	867.00	932.20
553.30	810.00	830.00	871.00	932.50
578.70	810.80	831.50	875.90	935.40
752.00	812.00	833.00	880.70	1004.00
760.00	812.00	840.00	881.00	1345.60
765.50	814.00	843.00	885.40	1500.00
767.00	814.00	844.80	891.20	1540.00
781.00	815.00	853.70	901.00	

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INTER-LABORATORY STUDY 1177

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 7

N	68	RANGE	4[illegible]0.30	C.I.(UPPER)	2073.69
TRUE-VALUE	1837.00	VARIANCE	293252.89	C.I.(LOWE R)	1816.25
MEAN	1944.97	STD. DEV.	541.53	SKEWNESS	1.13
MEDIAN	1909.35	COEF. VAR.	27.84	ACCURACY	3.94

DATA IN ASCENDING ORDER

147.70	1769.00	1880.00	1958.30	2104.60
1009.00	1778.00	1885.8[illegible]	1962.00	2115.10
1050.00	1786.40	1888.0[illegible]	1984.50	2133.00
1138.70	1803.50	1889.00	1985.00	2177.30
1227.30	1803.50	1897.00	1994.00	2190.10
1377.60	1818.30	1905.00	2015.90	2193.10
1428.10	1820.00	1913.70	2017.00	2267.90
1568.00	1827.30	1920.00	2026.90	2769.60
1643.00	1848.00	1925.00	2047.00	3177.00
1692.00	1849.20	1927.60	2051.10	3386.20
1740.10	1851.40	1928.00	2070.20	3503.00
1753.50	1858.00	1932.80	2081.60	4209.00
1765.00	1875.40	1950.00	2082.00	
1766.50	1876.00	1958.0[illegible]	2096.70	

INTER-LABORATORY STUDY 1177

POLLUTANT - NOX

UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 7

**** WITH OUTLIERS REMOVED ****

N	65	RANGE	2377.20	C.I.(UPPER)	2004.02
TRUE-VALUE	1837.00	VARIANCE	137593.79	C.I.(LOWE R)	1823.65
MEAN	1913.84	STD. DEV.	370.94	SKEWNESS	1.04
MEDIAN	1905.00	COEF. VAR.	19.38	ACCURACY	3.70

DATA IN ASCENDING ORDER

1009.00	1778.00	1885.8[illegible]	1962.00	2115.10
1050.00	1786.40	1888.0[illegible]	1984.50	2133.00
1138.70	1803.50	1889.00	1985.00	2177.30
1227.30	1803.50	1897.00	1994.00	2190.10
1377.60	1818.30	1905.00	2015.90	2193.10
1428.10	1820.00	1913.70	2017.00	2267.90
1568.00	1827.30	1920.00	2026.90	2769.60
1643.00	1848.00	1925.00	2047.00	3177.00
1692.00	1849.20	1927.60	2051.10	3386.20
1740.10	1851.40	1928.00	2070.20	
1753.50	1858.00	1932.80	2081.60	
1765.00	1875.40	1950.00	2082.00	
1766.50	1876.00	1958.00	2096.70	
1769.00	1880.00	1958.8[illegible]	2104.60	

INTER-LABORATORY STUDY 1177

POLLUTANT - NOX UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 9

N	67	RANGE	2691.00	C.I.(UPPER)	1703.13
TRUE-VALUE	1531.00	VARIANCE	194897.73	C.I.(LOWER)	1491.81
MEAN	1597.47	STD. DEV.	441.25	SKEWNESS	2.03
MEDIAN	1577.10	COEF. VAR.	27.62	ACCURACY	3.01

DATA IN ASCENDING ORDER

733.00	1468.80	1560.40	1637.00	1755.80
802.00	1499.50	1561.90	1656.60	1756.40
816.00	1503.10	1564.80	1657.20	1769.00
860.00	1508.00	1566.00	1671.20	1776.60
979.20	1524.10	1575.40	1671.20	1789.80
997.30	1529.00	1577.10	1685.10	1819.60
1157.40	1537.50	1580.00	1687.00	1954.20
1171.00	1539.00	1602.00	1691.00	1984.40
1257.00	1540.00	1604.90	1692.10	2997.90
1301.00	1542.70	1612.70	1695.50	3080.00
1344.50	1545.00	1614.00	1704.00	3624.00
1348.00	1550.00	1620.70	1725.00	
1370.50	1552.00	1623.00	1727.30	
1432.00	1552.00	1625.00	1734.50	

INTER-LABORATORY STUDY 1177

POLLUTANT - NOX UNITS - MILLIGRAMS PER DRY STD CUBIC METER

SAMPLE NUMBER - 9 **** WITH OUTLIERS REMOVED ****

N	64	RANGE	1151.40	C.I.(UPPER)	1584.09
TRUE-VALUE	1531.00	VARIANCE	66790.41	C.I.(LOWER)	1457.44
MEAN	1520.76	STD. DEV.	258.44	SKEWNESS	-1.49
MEDIAN	1570.70	COEF. VAR.	16.99	ACCURACY	2.59

DATA IN ASCENDING ORDER

733.00	1432.00	1552.00	1620.70	1704.00
802.00	1468.80	1552.00	1623.00	1725.00
816.00	1499.50	1560.40	1625.00	1727.30
860.00	1503.10	1561.90	1637.00	1734.50
979.20	1508.00	1564.80	1656.60	1755.80
997.30	1524.10	1566.00	1657.20	1756.40
1157.40	1529.00	1575.40	1671.20	1769.00
1171.00	1537.50	1577.10	1671.20	1776.60
1257.00	1539.00	1580.00	1685.10	1789.80
1301.00	1540.00	1602.00	1687.00	1819.60
1344.50	1542.70	1604.90	1691.00	1954.20
1348.00	1545.00	1612.70	1692.10	1984.40
1370.50	1550.00	1614.00	1695.50	

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